PROC. ENTOMOL. SOC. WASH.
92(2), 1990, pp. 259–270

FIRST RECORD OF A BAGWORM MOTH FROM HAWAII: DESCRIPTION AND INTRODUCTION OF *BRACHYCYTTARUS GRISEUS* DE JOANNIS (LEPIDOPTERA: PSYCHIDAE)

DONALD R. DAVIS

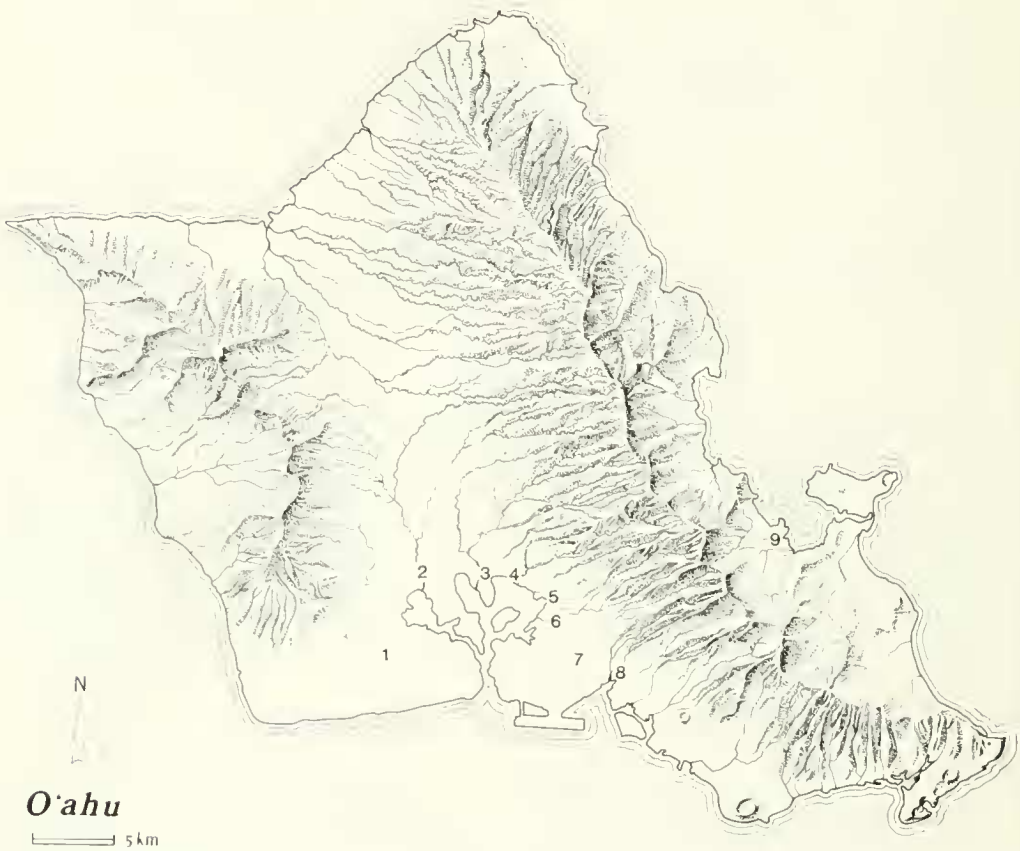
Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

Abstract.—Until recently no representative of the bagworm family Psychidae was known to occur in the Hawaiian Islands. The first infestation of *Brachycyttarus griseus* De Joannis was discovered during 1984 in a residential area of Haiku on Oahu. The species has since spread to several areas on Oahu and Kauai, where the larvae feed on the introduced grass, *Paspalum conjugatum* Berg. Originally described from Vietnam, *B. griseus* has also become established in Guam where it is parasitized by a tachinid fly, *Stomatomyia* species. All stages of *B. griseus* are described and illustrated and a map showing its present Hawaiian distribution is included.

Key Words: Lepidoptera, Psychidae, bagworm, introduced species, Hawaii

Until 1984 no species of the bagworm family Psychidae was known to occur in the Hawaiian Islands. In 1984 I received specimens, which I later determined as *Brachycyttarus griseus* De Joannis, from Po-Yung Lai of the Hawaii Department of Agriculture. The infestation was discovered in a residential area of Haiku (Kaneohe, see Map 1), Oahu. This site is about 15 mi [24 km] from Honolulu Harbor, the largest shipping dock in Hawaii, and about 17 mi [27 km] from Honolulu International Airport. The bagworm is now established on Oahu and has been encountered at nine different sites in or near Honolulu and Kaneohe (Map 1). The larva is known to feed on Hilo grass, *Paspalum conjugatum* Berg, another introduced species that has already interfered with the propagation of several rare endemic plants (Vitousek et al. 1987). On Guam the larva is reported to feed on *Zoysia pungens* Willd. (= *japonica* Steud.) and "mixed native grasses" (Muniappan, in litt.).

Brachycyttarus griseus was first reported from Hanoi, Vietnam (De Joannis 1929). Considering the magnitude of traffic and shipping from Vietnam, particularly within the previous two decades, it is likely that fertile females or eggs were introduced into Honolulu during that period. However, little is known about the present species distribution. From adults examined in the Smithsonian Institution (USNM), it is apparent that *B. griseus* has existed in the Philippines for some time. Several specimens were collected at Los Baños, Luzon, some as early as 1918. Labels indicate that a few specimens were reared from grass, thus agreeing with all other host records of *B. griseus*. Also present in the same collection is a series of grass-covered cases from Serdany, Malaysia that is identical to the Hawaiian material. No adults were reared from the Malaysian cases. On the basis of specimens and reports received from R. Muniappan, L. Stevens, and R. Shook of



Map. 1. Distribution of *Brachycyttarus griseus* in Oahu. Localities represented are: 1, Ewa; 2, Waipahu; 3, Pearl City; 4, Waimalu; 5, Ajea/Halawa; 6, Aliamanu/Moanalua; 7, Salt Lake; 8, Kalihi; 9, Kaneohe.

the University of Guam, this grass-feeding bagworm was well established on Guam by 1977. Thus, the Hawaiian population could have originated from several sources, with either Vietnam or Guam perhaps the most likely.

No parasites have been reared from the Hawaiian bagworm population. Dipterous parasites reared from *B. griseus* in Guam and submitted by R. Shook have been identified by C. W. Sabrosky as Tachinidae: *Stomatomyia* species.

To facilitate the recognition of *B. griseus,* which has become more widely distributed and, thus, of greater public concern, a description of all developmental stages is provided.

Brachycyttarus griseus De Joannis
Figs. 1–48; Map 1

Brachycyttarus griseus De Joannis, 1929: 543.—Dierl, 1971: 61.

Acanthopsyche (*Brachycyttarus*) *griseus* (De Joannis).—Gaede, 1933: 735.

Adult (Figs. 1–2).—Length of forewing: ♂, 6.5–7.4 mm. A moderately small, slender, broad wing moth with uniformly dark gray wings except for short, grayish white fringe on outer margin of both wings. Apex of cucullus on male genitalia with 3 small spines. Female vermiform, naked, and without wings or segmented appendages. Larva with 6 stemmata, the most caudal 3 pairs with vestigial, flattened lenses.

Head: Vestiture sparse, gray. Mouthparts absent. Antenna 18–20 segmented, bipectinate with long slender branches; antennal sensilla long, length about 6–7× the diameter of supporting branch.

Thorax: Sparsely covered with brownish gray to gray piliform scales dorsally over dark cuticle, scales light gray to white ventrally. Forewing uniformly dark gray dorsally and ventrally with grayish white, outer fringe scales. Hindwing slightly lighter gray dorsally, mostly white ventrally; fringe grayish white. Legs with femora dark gray, tibiae and tarsi light brown to stramineous. Foreleg the longest; epiphysis long and slender, about 0.8 the length of tibia. Midleg and hindleg without tibial spurs.

Abdomen: Vestiture dark gray dorsally, grayish white ventrally; cuticle dark reddish brown to black. Eighth tergite (Fig. 41) and sternite (Fig. 42) as illustrated.

Male genitalia (Figs. 39–40): Tegumen and vinculum relatively elongate, broadly rounded. Valva approximately half the length of genitalia, divided apically into a smoothly rounded costal lobe and a smaller cucullar lobe bearing 3 short spines. Aedoeagus approximately same length as genitalia, straight, relatively stout, with caudal end slightly enlarged.

Female genitalia (Fig. 44): Anal papillae reduced to a pair of faintly setose lobes. Apophyses absent. Corpus bursae reduced to a small, digitate lobe anterior to short, broad ductus seminalis. Ductus spermathecae elongate, slender, not coiled.

Egg (Figs. 5–6).—Length approximately 0.44–0.56 mm; width 0.35–0.4 mm. Chorion smooth with stellate micropyle at one end; micropyle with 22–25 slender low ridges radiating out from central disk; arms occasionally anastomosing, forming closed cells.

Larva (Figs. 7–22, 31–38).—Length of largest larva 15 mm; maximum diameter 2.6 mm. Body color mostly white with scattered dark pigmentation over head and thoracic plates.

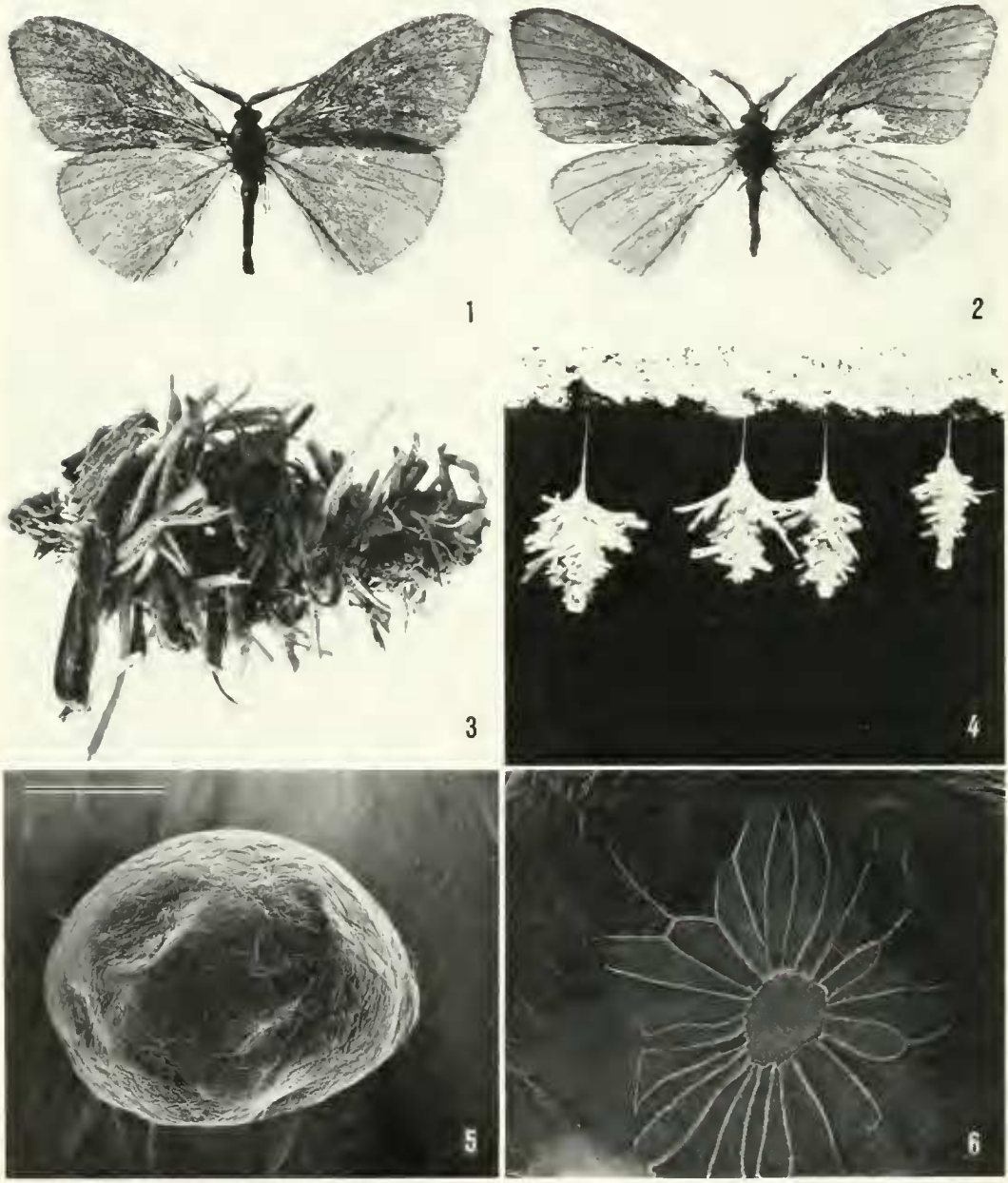
Head: Maximum width 1.5 mm. Pigmentation as in Fig. 32. AF2 elongate, extending to labrum. Six pairs of stemmata present; anterior three pairs (3–5) normal, posterior three (1–2, 6) slightly reduced with flattened corneas. S2 arising equidistant between stemmata 1 and 6 or closer to 1. Labrum with four pairs of almost equal size epipharyngeal setae. Mandible irregularly truncate; distinct cusps barely discernible. Sensilla of antenna as in Figs. 15–17; maxillary palpus as in Figs. 11–12.

Thorax: Lightly pigmented as shown in Fig. 31. Pronotum with D1 approximate to XD1. Coxal plates fused medially, with a pair of prominent lobes projecting anteriorly between coxal setae; C1 the longest. Meso- and metanotum with L2 separate from pinacula bearing L1 and 3. Tarsal claw relatively long and straight, with a small axial spine (Figs. 19–20).

Abdomen: Pinacula usually poorly defined. D1 and 2 on separate pinacula except on A8 where they arise together on a relatively large pinaculum. SD2 minute, separate from pinaculum bearing SD1 and usually slightly above and anterior to spiracle. L1 and 2 together on same pinacula on A1–2, separate on A3–9. A9 with D2 and SD1 on same pinacula. Prolegs A3–6 with 20–22 crochets in lateral penellipse; anal proleg with 15–17 crochets.

Larval case (Fig. 3).—Length 10–15 mm; diameter approximately 5–6 mm. Exterior of case densely covered with brownish grass fragments, roughly spirally arranged, thus imparting a very shaggy appearance. For pupation, case is suspended by a slender, silken strand about 0.5–1.0 the length of case (Fig. 4).

Male pupa (Figs. 23–26, 47–48).—Maximum length 6 mm; width 1.6 mm. Young pupa light brown, darkening with age until head and thorax and all appendages dark fuscous to black as well as narrow dorsal and ventral interrupted band composed of terga and sterna of A1–8. Vertex smooth, subtruncate; frontal ridge absent. Antennal



Figs. 1–6. *Brachycyttarus griseus*. 1, Male, Kaneohe, Oahu, length of forewing 6.9 mm. 2, Male holotype, Hanoi, Vietnam, length of forewing 6.6 mm. 3, Larval case, length 13 mm. 4, Larval cases, attachment for pupation. 5, Egg (176 μm). 6, Micropyle of egg (43 μm). (Scale lengths in parentheses; bar scale for Fig. 6 = Fig. 5.)

sheath extending to A3. Wing sheaths approximately same length, to middle of A3. A6–8 with a relatively short anterior row of dorsal spines as follow: A6 = 7–9 spines; A7 = 10–13; A8 = 7–10. Posterior row of dorsal spines absent. Cremaster composed of a stout pair of acute, anteriorly directed spines from venter of A10 (Figs. 25–26).

Female pupa (Figs. 27–30, 45–46).—Maximum length 7 mm; width 2.8 mm. Light brown to stramineus in color. All body appendages either absent or reduced to minute tubercules. Abdomen with both anterior and posterior dorsal spine rows reduced and present but never together on same segment; anterior row present only on A6 (= 11–14 spines) and A7 (= 10–13); posterior rows present on A1 (= 35–40), A2 (= 17–21), A3 (= 17–20), A4 (= 10–12); A5 without either anterior on posterior spine rows. Cremaster composed of a relatively slender, more reduced pair of anteriorly directed spines from venter of A10 (Figs. 29–30).

Type.—Holotype, ♂; in the Muséum National d'Histoire Naturelle, Paris.

Type locality.—Vietnam: Hanoi.

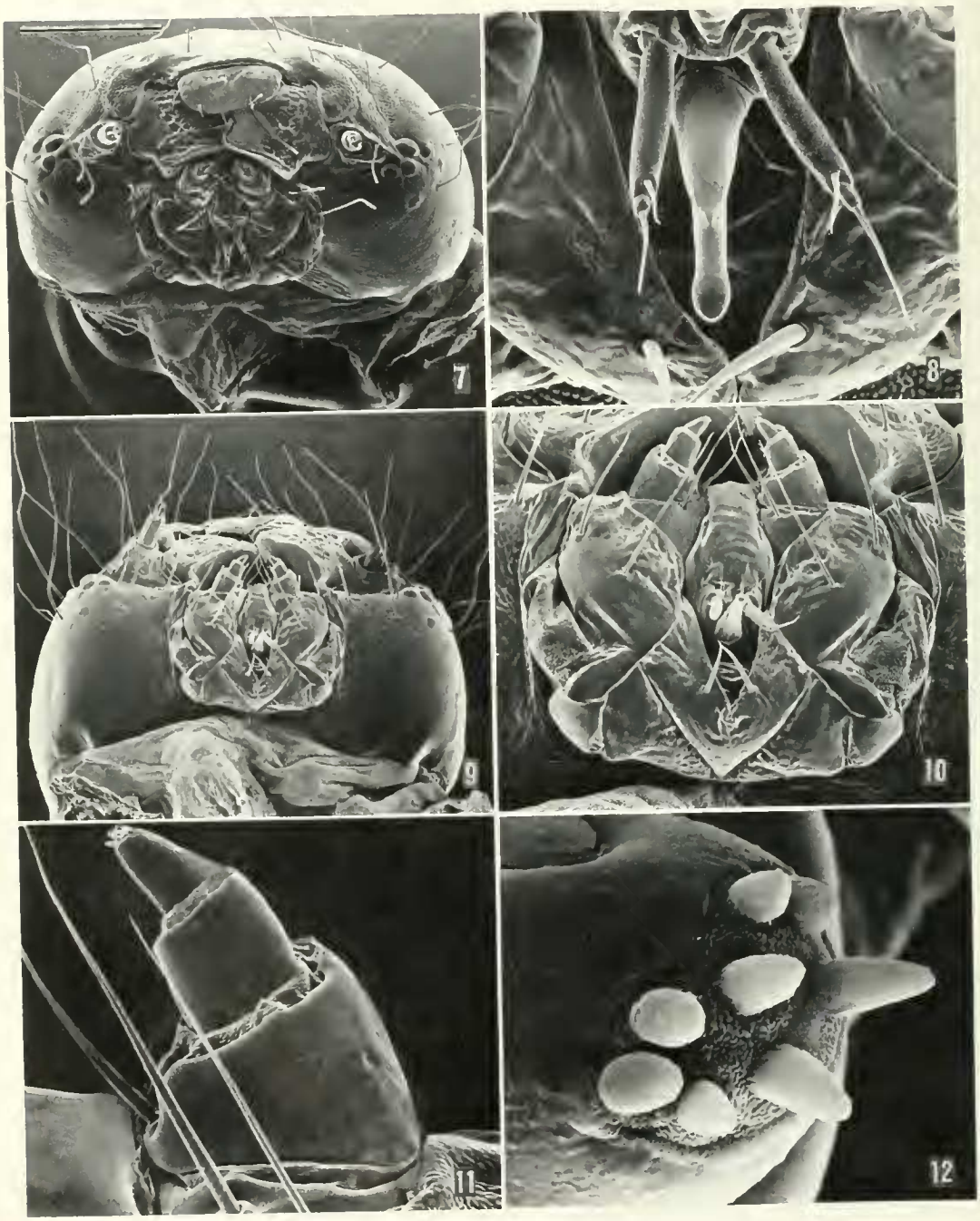
Host.—Poaceae: *Paspalum conjugatum* Berg, *Zoysia pungens* Willd. (= *japonica* Steud.) and probably other grasses.

Parasite.—Tachinidae: *Stomatomyia* species.

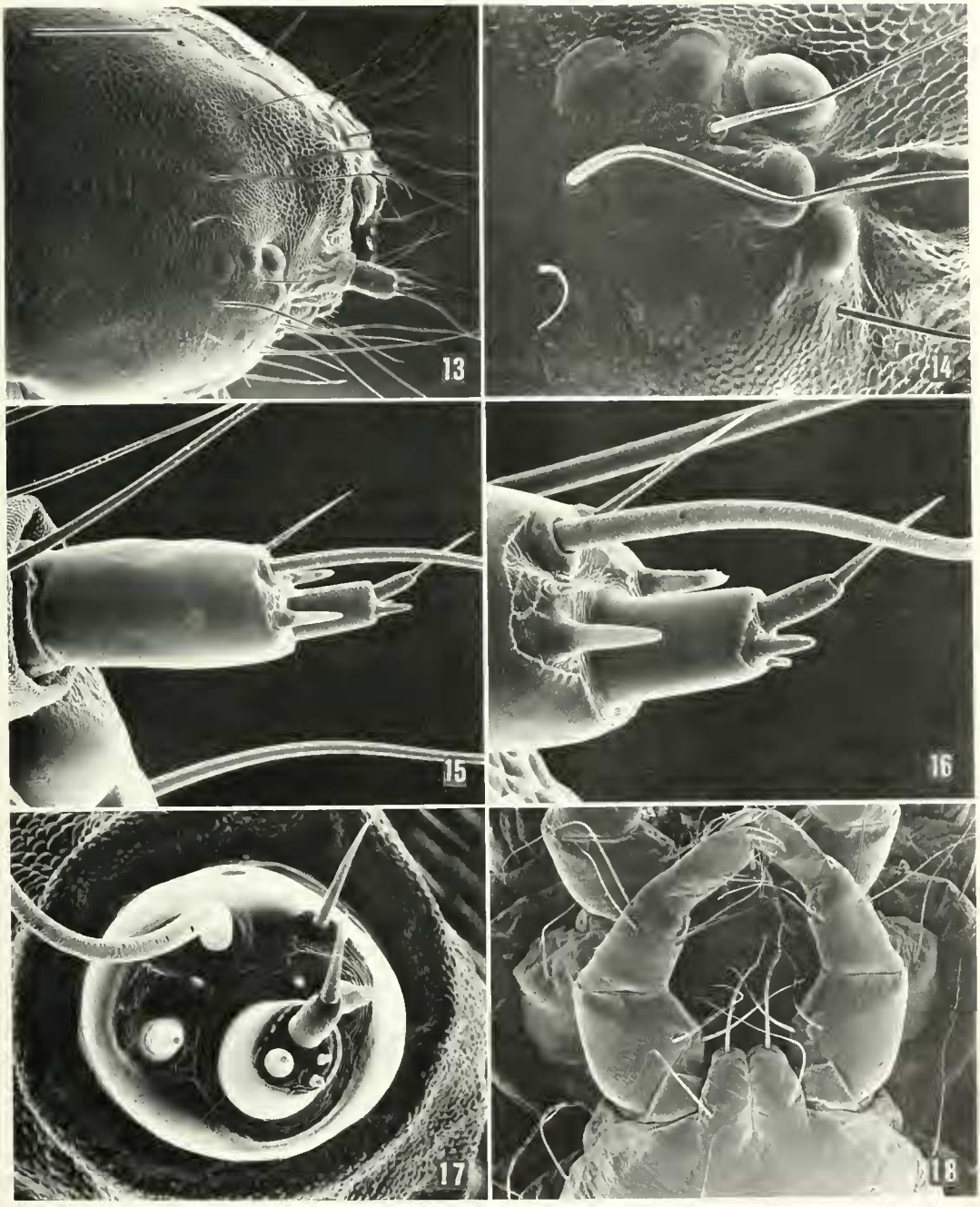
Distribution (Map 1).—Definitely known to occur in Vietnam, Philippines, Guam, and Hawaii, but probably widely distributed in southeast Asia. In Hawaii, reported only from Oahu and Kauai below 150 meters, but in time will undoubtedly spread to other major islands.

Discussion.—In his review of a few Asiatic Psychidae, Dierl (1971) treats five species of *Brachycyttarus*. Most of the species are similar in general appearance, with similar male genitalia. Consequently, species identification within this complex is difficult and still hindered by some uncertainties. Only one species, *B. fuscus* Dierl, lacks the white scales on the underside of the hindwing. Dierl illustrates the wing venation of four of the five species and indicates that both *B. griseus* and *B. fasciatus* Dierl are similar in having M2 and 3 converge at the outer margin of the hindwing (see Fig. 43). Although I have noted some venational variation in the specimens examined, the wing structure of the Hawaiian species appears closest to that illustrated for *B. fasciatus*. This is particularly evident in the stalking of R2+3 with R4+5 in the forewings and the abbreviated length of the basal radial cell in the hindwing. Lacking in Dierl's drawing of *fasciatus* is the presence of a basal stem of R that is separate from Sc as shown in Fig. 43. Partly because the male genitalia of the Hawaiian species most resemble that of *B. griseus*, I have considered them conspecific. Although the hosts of *B. fasciatus* are not stated, Dierl's comments that the larva is polyphyagous and lives only in forests under large trees and small shrubs do not suggest the species attacking grasses in Guam and Hawaii. De Joannis (1929) likewise did not state the host of *B. griseus*, but he did describe the larval case as being covered with grass fragments, which suggests grass as the foodplant. The type locality of *B. fasciatus* (Jhawani, Nepal, 200 m) also suggests a more northern species than *B. griseus*. The wing fringe of *fasciatus* was described as brown by Dierl, compared to grayish white in the Hawaiian specimens. This character has to be used with discretion, however, as only the outer fringe scales are pale colored, and these are frequently lost in rubbed specimens, as is true for the type of *B. griseus* (Fig. 2) and in most of the specimens I have examined from Guam and Hawaii.

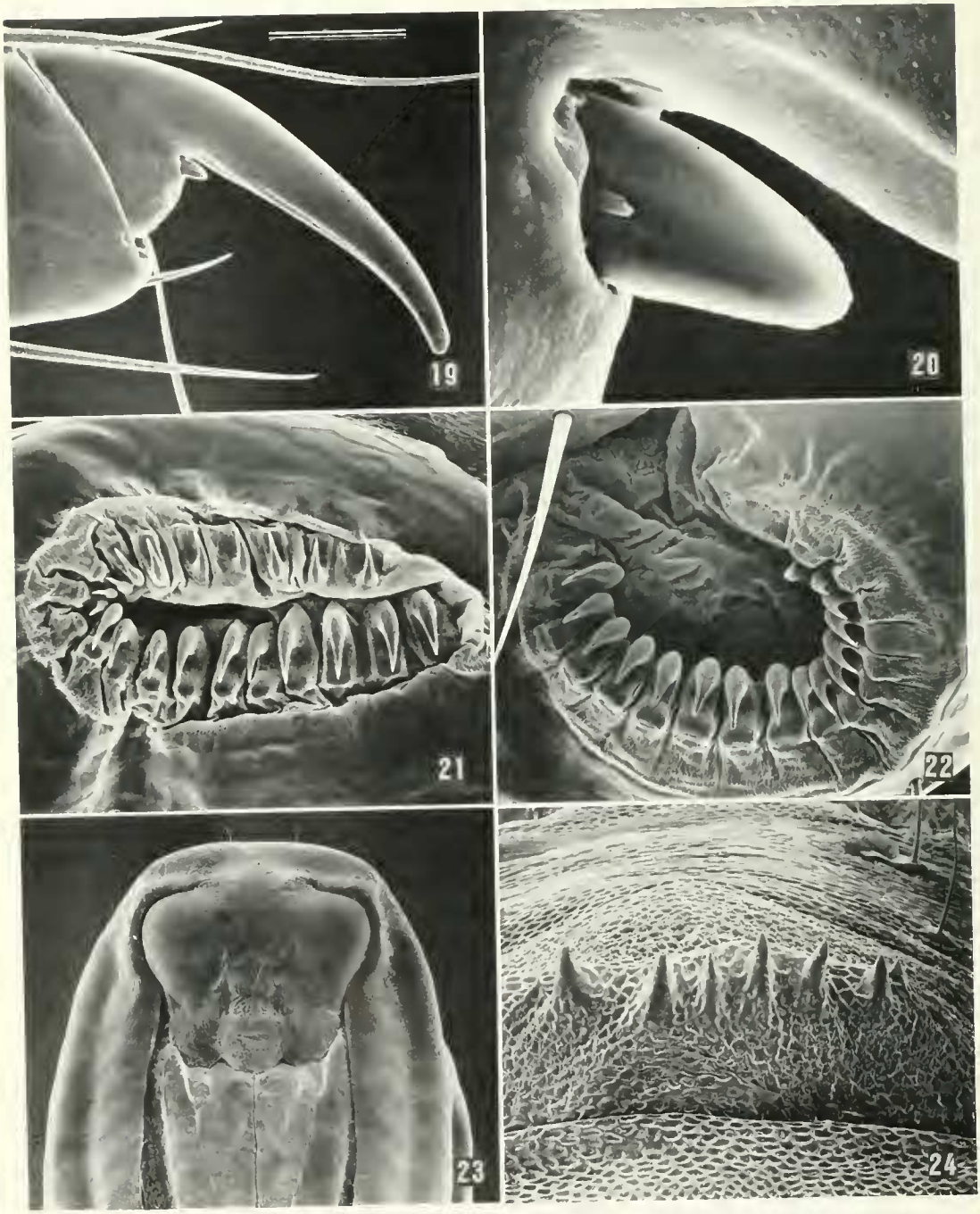
Dierl has introduced another problem in this small but troublesome genus with regard to the relatively unknown Javan species, "*Pteroma*" *reijnvaanii* Van Leeuwen. Because the original illustrations of the adult and larval case of this species most resemble *B. griseus*, *reijnvaanii* could be the senior synonym of the former. Presently this is impossible to resolve because of the in-



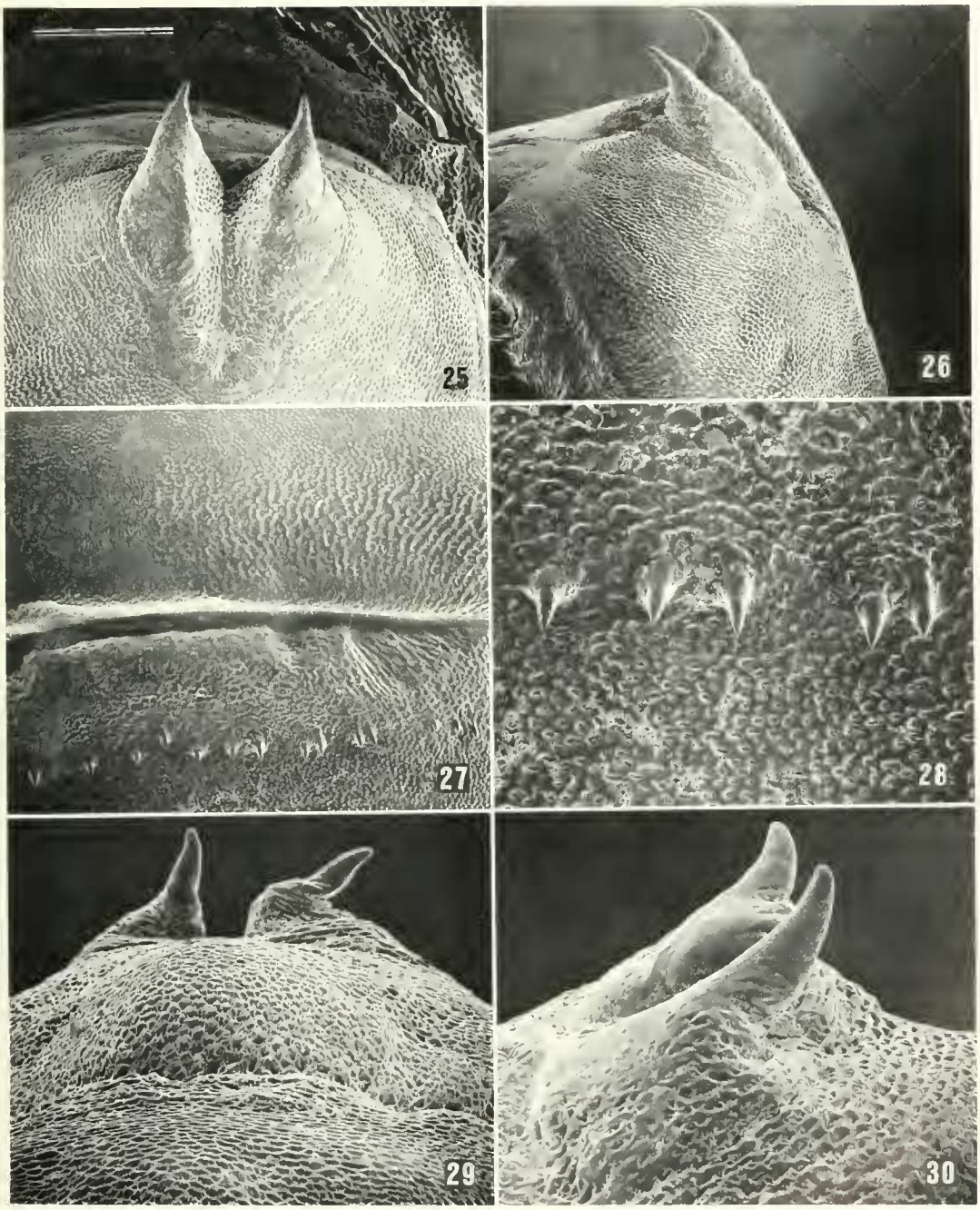
Figs. 7–12. *Brachycyttarus griseus*, larva. 7, Anterior view of head (0.43 mm). 8, Labial palpi and spinneret (60 μm). 9, Ventral view of head (0.46 mm). 10, Maxilla and labium, ventral view (200 μm). 11, Maxillary palpus (50 μm). 12, Apical sensilla basiconica of maxillary palpus (5 μm). (Scale lengths in parentheses; bar scale for all photographs = Fig. 7.)



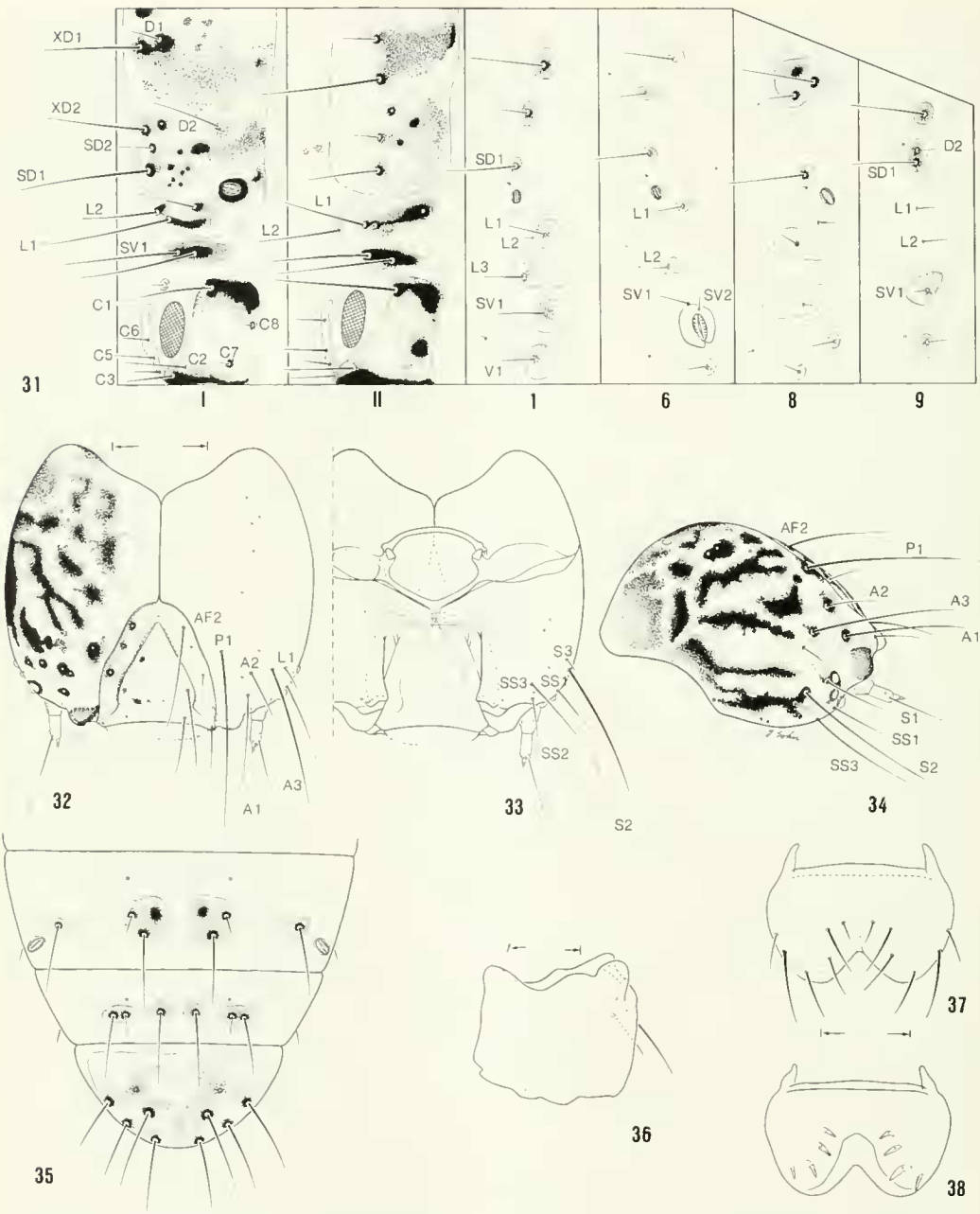
Figs. 13–18. *Brachycyttarus griseus*, larva. 13, Lateral view of head (0.3 mm). 14. Detail of stemmatal area (100 μm). 15, Antenna (60 μm). 16, Detail of Fig. 15 (30 μm). 17, Apical view of antenna (27 μm). 18, Mesothorax, ventral view (0.43 mm). (Scale lengths in parentheses; bar scale for all photographs = Fig. 13.)



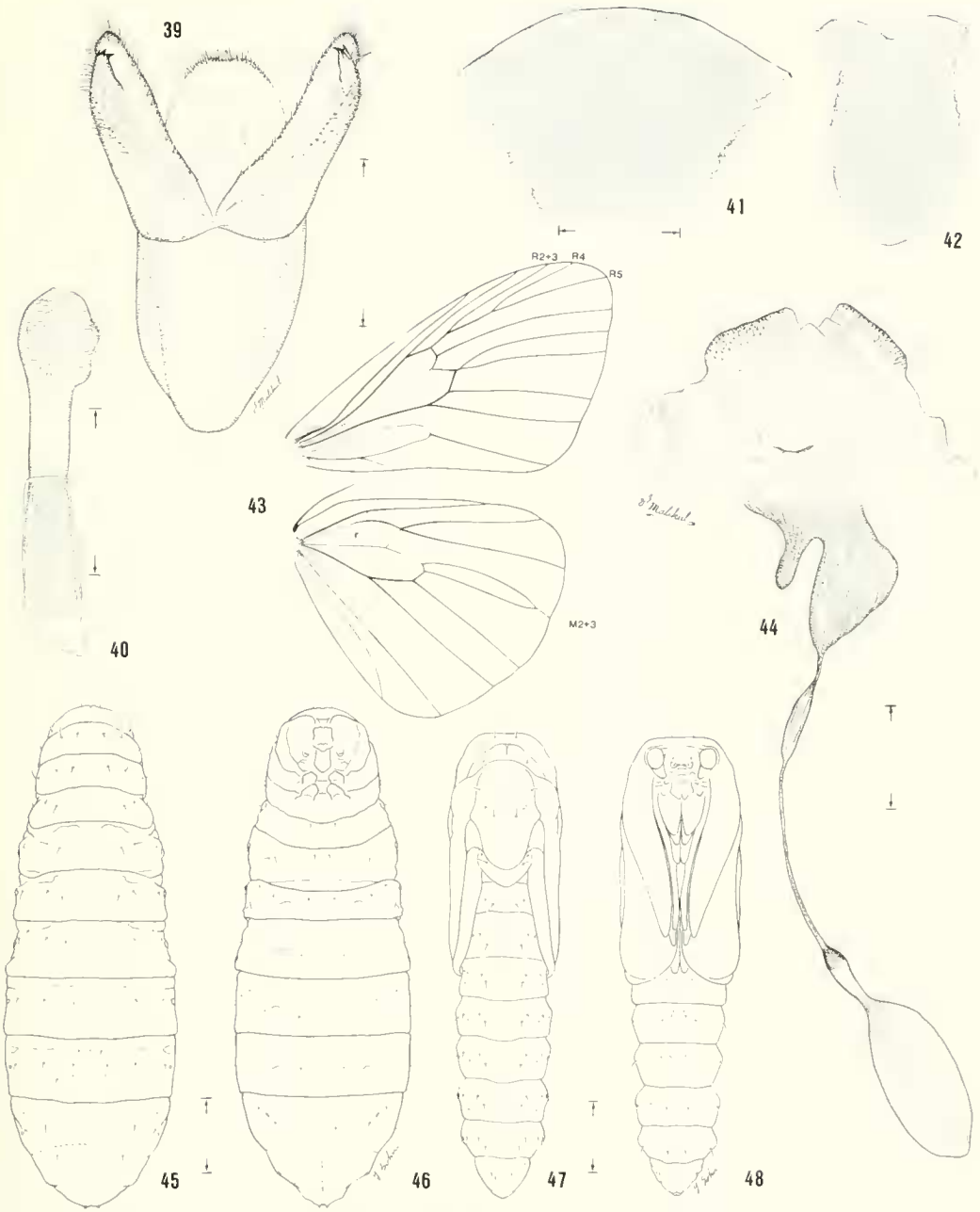
Figs. 19–24. *Brachycyttarus griseus,* larva and pupa. 19, Prothoracic tarsal claw (50 μm). 20, Detail of axial seta in Fig. 19 (5 μm). 21, Crochets of A6 (60 μm). 22, Anal crochets, A10 (60 μm). 23, Male pupa, ventral view of head (0.6 mm). 24, Male pupa, anterior row of dorsal spines A8 (86 μm). (Scale lengths in parentheses; bar scale for all photographs = Fig. 19.)



Figs. 25–30. *Brachycyttarus griseus*, pupae. 25, Male cremaster, A10, caudal view (136 μm). 26, Lateral view of Fig. 25 (150 μm). 27, Female, dorsum of A6 and 7, with anterior spines on A7 (231 μm). 28, Detail of A7 spines in Fig. 27 (75 μm). 29, Female cremaster, A10, anterior view (100 μm). 30, Lateral view of Fig. 29 (60 μm). (Scale lengths in parentheses; bar scale for all photographs = Fig. 25.)



Figs. 31–38. *Brachycyttarus griseus*, larval chaetotaxy. 31, Lateral view of prothorax, mesothorax, and abdominal segments 1, 6, 8, and 9. 32, Dorsal view of head (0.5 mm). 33, Ventral view. 34, Lateral view. 35, Dorsal view of A8–10. 36, Mandible (0.2 mm). 37, Labrum, dorsal view (0.2 mm). 38, Ventral view showing epipharyngeal setae. (Scale lengths in parentheses.)



Figs. 39–48. *Brachycyttarus griseus*. 39, Male genitalia, ventral view (0.25 mm). 40, Aedoeagus. 41, Tergite, A8 (0.25 mm). 42, Sternite, A8. 43, Wing venation. 44, Female genitalia (0.25 mm). 45, Female pupa, dorsal view (1.0 mm). 46, Ventral view. 47, Male pupa (1.0 mm). 48, Ventral view. (Scale lengths in parentheses.)

adequacy of the original description and the subsequent disappearance of all type material.

All eggs examined in this study, including Figs. 5 and 6, were removed from the bodies of preserved females. Consequently, their relative dimensions or even surface texture may not be typical of deposited eggs. These data eventually need to be compared with externally collected eggs for possible discrepancies.

Because this report includes the first description of the egg, larva, and pupa for any member of *Brachycyttarus*, it is not possible to compare these stages between related species. Possible diagnostic larval characters for *B. griseus* involve the elongate AF2 seta, the relative reduction of the posterior three stemmata (Fig. 14), and the reduction of the SD1 pinaculum on A9 with the consequent separation of SD2 and L1 from SD1. Comparisons involving the sensilla of the larval maxilla and antenna must await considerably more SEM work with psychid larvae. The relative amount or distribution of larval head and body pigmentation could be of some significance, although this can vary both within and between instars.

The male pupa of *B. griseus* is unusual in completely lacking the posterior row of anteriorly oriented, dorsal abdominal spines typical of most Psychidae studied (Davis 1975). The anterior row is present but only on segments A6–8. As is typical for vermiform females, the dorsal spines are greatly reduced in size in the female pupa, but their distribution is unusual. No abdominal segment possesses a full complement of both anterior and posterior rows and A5 is totally lacking in spines. Again, whether these characters are significant at the specific or generic level must await discovery of other *Brachycyttarus* pupae.

Acknowledgments

I wish to thank Po-Yung Lai of the Pest Control Branch, Hawaii Department of Agriculture and several of his staff for specimens and data of *Brachycyttarus griseus* from Oahu. In particular, I am grateful for the efforts of George Funasaki, Ron Hue, and Bernarr Kumashiro. Similarly, I also wish to acknowledge Scott Miller of the Bishop Museum and Hidiyuki Chiba of the University of Hawaii for helpful assistance. I am grateful to Dan Otte of the Philadelphia Academy of Natural Sciences for the outline map of Oahu and to George Funasaki for the latest distributional records of *B. griseus* on Oahu. Thanks also go to R. Muniappan, L. Stevens, and Rosalie Shook of the University of Guam for study material from Guam. I am indebted to Vichai Malikul and Young Sohn of the Department of Entomology, Smithsonian Institution, for the line drawings and to Susann Braden and Brian Kahn of the Smithsonian SEM Lab and Victor Krantz of the Smithsonian Photographic Laboratory for photographic assistance. I am thankful to Allan Watson and the British Museum (Natural History) and Joel Minet of Muséum National d'Histoire Naturelle for allowing me to study type material in their collections. I am grateful to Silver West of our Department for preparing the final draft of the manuscript.

Literature Cited

Davis, D. R. 1975. A review of the West Indian moths of the family Psychidae with descriptions of new taxa and immature stages. Smithsonian Contributions to Zoology 188: 1–66, figs. 1–206, tables 1–5.

Dierl, W. 1971. Biologie und Systematik einiger Asiatischer Psychidae-Arten (Lepidoptera). Entomologischen Abteilung der Zoologischen Staatssammlung München, Khumbu Himal 4(1): 58–79, figs. 1–21.

Gaede, M. 1933. Psychidae. *In* A. Seitz, The Macrolepidoptera of the World, 10 (Fauna Indoaustralica): 729–742.

Joannis, J. De. 1929. Lépidoptères Hétérocères du Tonkin, pt. 2. Annales de la Société Entomologique de France 98(4): 361–557, pls. 3–6.

Vitousek, P. M., L. L. Loope, and C. P. Stone. 1987. Introduced species in Hawaii: Ecological effects and opportunities for research. Trends in Ecology and Evolution 2(7): 224–227.